Claims

[c1] 1.An optical coupling system for coupling optical energy between optical devices, the system comprising:
a waveguide receptive of N-mode radiation from a radiation source where N is an integer;
the waveguide comprising:
a first section receptive of the N-mode radiation from the optical beam redirection device and having a thickness of h;
a second section having a thickness of t wherein t is less than h; and
a tapered section having a first end thereof with a thickness of h joined with the first waveguide section and a second end thereof with a thickness of t joined with the second waveguide section for coupling the N-mode radiation from the first waveguide section to the second waveguide section.

[c2] 2.The optical coupling system as set forth in Claim 1 further comprising an optical beam redirection device receptive of the N-mode radiation from the radiation source for directing the N-mode radiation to the first waveguide section.

[c3] 3.The optical coupling system as set forth in Claim 1 wherein h is approximately 10-100 um and t is approximately 2-10 um.

[c4] 4.The optical coupling system as set forth in Claim 1 wherein the tapered section has a length of approximately 100-1000 um.

[c5] 5.The optical coupling system as set forth in Claim 1 wherein the first end of the tapered section includes a first aperture and the second end of the tapered section includes a second aperture substantially parallel to the first aperture wherein the first and second apertures are spaced apart from one another so that the tapered section subtends a first angle, α , of about 5-10 degrees and a second angle, β , perpendicular to the first angle, α , of about 5-10 degrees at the second waveguide section.

[c6] 6.The optical coupling system as set forth in Claim 2 wherein the optical beam redirection device comprises a prism.

[c7] 7.The optical coupling system as set forth in Claim 2 wherein the optical beam redirection device comprises a lens or a diffraction grating.

[c8] 8.The optical coupling system as set forth in Claim 1 further comprising a cladding having a refractive index of n_w and encasing the waveguide having a refractive index of n_c; wherein n_w is less than n_c.

[c9] 9.The optical coupling system as set forth in Claim 1 wherein the first waveguide section and the tapered section are defined by a refractive index, n_w, and the second waveguide section is defined by a refractive index, n_c, and wherein n_c is greater than n_w.

[c10] 10.The optical coupling system as set forth in Claim 9 wherein the second waveguide section is a cladding encasing the optical beam redirection device, the first waveguide section and the first tapered section.

[c11] 11.The optical coupling system as set forth in Claim 9 wherein the second waveguide section further comprises a top-layer tapered section wherein the refractive index difference between the second waveguide section and the tapered section is extended from an upper surface of the second waveguide section to a point along the tapered section.

[c12] 12.The optical coupling system as set forth in Claim 9 wherein the second waveguide section includes a segment thereof positioned within the first tapered section.

[c13] 13.The optical coupling system as set forth in Claim 12 wherein the segment of the second waveguide section positioned within the first tapered section is a wedge having a triangular in cross section including a base with a length t joined with the second waveguide section and an angled apex opposed to the base;
wherein the wedge is receptive of the N-mode radiation from the first tapered section for coupling the N-mode radiation from the first waveguide section to the second waveguide section.

[c14] 14.The optical coupling system as set forth in Claim 13 wherein the triangular

cross section is inclined with respect to the second waveguide section.

[c15] 15.The optical coupling system as set forth in Claim 9 wherein the second waveguide section includes a segment thereof positioned within the first tapered section and the first waveguide section.

[c16] 16.The optical coupling system as set forth in Claim 13 wherein the angled of the wedge includes an angle of about 5-10 degrees.

[c17] 17.The optical coupling system as set forth in Claim 13 wherein the wedge includes a length of about 100-1000 um.

[c18] 18.An optical coupling system for coupling optical energy between optical devices, the system comprising:
a first waveguide having a thickness of c and a refractive index of n_w, and receptive of the N-mode radiation from a radiation source along an axis;
a second waveguide having a segment thereof positioned within the first waveguide and having a thickness of t, wherein t is less than c and a refractive index of n_c wherein n_c is greater than n_w.

[c19] 19.The optical coupling system as set forth in Claim 18 further comprising an optical beam redirection device receptive of the N-mode radiation from the radiation source for directing the N-mode radiation to the first waveguide
N is an integer.

[c20] 20.The optical coupling system as set forth in Claim 18 wherein the segment of the second waveguide positioned within the first waveguide includes a wedge having a triangular in cross section including a base with a length t joined with the second waveguide section and an angled apex opposed to the base;
wherein the wedge is receptive of the N-mode radiation from the optical beam redirection device for coupling the N-mode radiation from the optical beam redirection device to the second waveguide section.

[c21] 21.The optical coupling system as set forth in Claim 20 wherein the wedge is inclined with respect to the second waveguide section.

[c22] 22.The optical coupling system as set forth in Claim 20 wherein the angled

of the wedge includes an angle of about 5-10 degrees.

[c23] 23.The optical coupling system as set forth in Claim 20 wherein the wedge includes a length of about 100-1000 um.

[c24] 24.The optical coupling system as set forth in Claim 19 wherein a segment of the first waveguide is truncated by a distance d.

[c25] 25.The optical coupling system as set forth in Claim 19 wherein the second waveguide is offset from the axis of the N-mode radiation by a distance r.

[c26] 26.An optical coupling system for coupling optical energy between optical devices, the system comprising:
an optical beam redirection device receptive of N-mode radiation from a radiation source where N is an integer;
a waveguide having a refractive index of n_w and receptive of the N-mode radiation from the optical beam redirection device along an axis;
the waveguide comprising:
a first section receptive of the N-mode radiation from the optical beam redirection device;
a tapered section receptive of the N-mode radiation from the first waveguide section; and
a third section positioned within the tapered section, the third section having a refractive index of ns and receptive of the N-mode radiation from the tapered section;
wherein ns is greater than n_w.

[c27] 27.The optical coupling system as set forth in Claim 26 wherein the third waveguide section is offset from the axis of the N-mode radiation by a distance r.

[c28] 28.A waveguide device comprising:
a first aperture having a first cross sectional area and receptive of optical radiation;
a second aperture having a second cross sectional area less than the first cross sectional area and receptive of the optical radiation from the first aperture.

[c29] 29.The waveguide device as set forth in Claim 28 wherein the waveguide device defines first and second angles between the first and second apertures wherein the first angle, α , is about 5-10 degrees and the second angle, β , perpendicular to the first angle, α , is about 5-10 degrees.

[c30] 30.The waveguide device as set forth in Claim 28 wherein the waveguide device has a length of approximately 100-1000 um.

[c31] 31.An optical coupling system for coupling optical energy between optical devices, the system comprising:
an optical beam redirection device receptive of N-mode radiation from a radiation source where N is an integer;
a waveguide receptive of the N-mode radiation from the optical beam redirection device;
the waveguide comprising:
a first section receptive of the N-mode radiation from the optical beam redirection device and having a thickness of h;
a tapered section having a first end thereof with a thickness of h joined with the first waveguide section and a second end thereof with a thickness of t for coupling the N-mode radiation from the first waveguide section to a second waveguide.

[c32] 32.The optical coupling system as set forth in Claim 31 wherein the first end of the tapered section includes a first aperture and the second end of the tapered section includes a second aperture substantially parallel to the first aperture wherein the first and second apertures are spaced apart from one another so that the tapered section subtends a first angle, α , of about 5-10 degrees and a second angle, β , perpendicular to the first angle, α , of about 5-10 degrees at the second waveguide.

[c33] 33.An optical coupling system for coupling optical energy between optical devices, the system comprising:
a radiation source;
an optical beam redirection device positioned a prescribed distance from the radiation source and receptive of N-mode radiation therefrom where N is an

integer;

a waveguide receptive of the N-mode radiation from the optical beam redirection device;

the waveguide comprising:

a first section receptive of the N-mode radiation from the optical beam redirection device and having a thickness of h;

a second section having a thickness of t wherein t is less than h; and

a tapered section having a first end thereof with a thickness of h joined with the first waveguide section and a second end thereof with a thickness of t joined with the second waveguide section for coupling the N-mode radiation from the first waveguide section to the second waveguide section.

[c34] 34.The optical coupling system as set forth in Claim 33 wherein the first end of the tapered section includes a first aperture and the second end of the tapered section includes a second aperture substantially parallel to the first aperture wherein the first and second apertures are spaced apart from one another so that the tapered section subtends a first angle, α , of about 5-10 degrees and a second angle, β , perpendicular to the first angle, α , of about 5-10 degrees at the second waveguide section.